

memorandum

Date: November 21, 2011

To: Jeremy Freimund, Lummi Water Resources Manager

From: Jim Johannessen, LEG, MS, and Jonathan Waggoner, BS

Re: Brant Spit Historic Shore Change Analysis

Introduction and Purpose

The purpose of this study was to document recent changes to Brant Spit utilizing both historic information and present conditions. This information will be compared to baseline conditions established in 2003, as well as new data survey data collected by CGS and LIDAR data provided by the Lummi Indian Nation. The intent of the study was to provide guidance for management of nearshore marine, coastal, and adjacent upland areas in the vicinity of Brant Spit and Portage Bay on the Reservation.

Brant Spit is a long, narrow, sand and gravel spit extending from the eastern side of Portage Island northwestward toward the Lummi Peninsula (Figure 1). The primary source of sediment to the spit is the high bluffs of south and east Portage Island. Portage Island and Brant spit have not been developed, and the bluffs and beaches remain in a natural condition. The focus of this study was to document recent changes to the spit, and further the understanding of spit dynamics at this site.

Methods

Historic data used in the this study included previous survey work by CGS as well as 2008 LiDAR data provided by the Lummi Nation. CGS previously performed two ground surveys of Brant Spit, one in 2003 covering the majority of the spit, and another in 2005 that only measured the lowest portion of the spit near the base and the spit crest. LiDAR data was provided in NAVD88 vertical datum. The NOAA software tool VDatum was used to calculate a shift of +0.6 ft from NAVD88 to local MLLW (0.0 ft NAVD88 = +0.6 ft MLLW).

New survey data was collected on September 9, 2011 by Jim Johannessen and Jonathan Waggoner of CGS with a Leica TCR-1105 total station with direct rod measurements from previously established survey control. Each monument was occupied using a Trimble GoeXH mapping grade differential GPS in order to convert the assumed survey grid to a geographic coordinate system. Survey and GPS data were imported into AutoCAD Civil 3D 2011 for data reduction, correction, and comparison to prior data sets.

Historic and new data were compared for several spit features. First, gaps in the spit crest, as defined by the crest elevation being lower than MHHW, were measured along the spit crest and compared to previous data for length and location. Next, a comparison of the relative location of the spit crest was made. Lastly, a surface change analysis was completed to see how the spit has shifted location over time.

Results

General Observations

Beach topography from the 2011 CGS survey is shown in Sheet 1. The spit extended to the northwest from Portage Island with a vegetated backshore extending up to a crest of approximately +12 ft MLLW. Where the spit turned to trending north-northwest, the vegetation ended and the spit crest dropped as low

as +7.3 ft MLLW before rising gradually to +10.6 ft MLLW. The gap in the spit crest measured 443 ft between MHHW on either side. The low point was distinguished by a cobble armored beachface with very little fine sediment built into a low berm at the crest (Photo Page 1). The central portion of the spit was comprised of a broad low-tide terrace on the northeast shore with a moderate-sloped beachface extending up to +9.5 ft MLLW, and a steeper Portage Bay beachface. The spit again shifted orientation to the west where it included a wider area, Brant Point, characterized by an approximately 200 ft wide, flat, vegetated backshore of between +10 and +13 ft MLLW. At the western terminus of the spit, it extended down into the intertidal again before giving way to deeper water.

A 10 ft wide diagonal cut through the spit crest was seen approximately 500 ft from the base of the spit (Photo Page 1). This area, which was about 1 ft lower than the surrounding area, has apparently been used for vehicular access to the rest of the spit. During the survey a truck was seen driving through the rutted section of spit.

The east end of the broad Brant Point had been eroded substantially in recent years. The erosion had exposed a large mass of peat on the beachface during the time of the 2011 survey (Photo Page 2). The peat layer is likely a remnant portion of backshore (Portage Bay) marsh later covered by the spit and subsequently eroded. A new gap in the MHHW line, measuring 33 ft, had opening at this location.

MHHW Gap

Since at least 2003, a low-elevation section of the spit near the base has been observed. This gap in the spit has been characterized as being entirely below MHHW. The causation of this has not been directly researched, but may be related to the periodic nature of sediment inputs into the littoral system from up-drift erosion events as well as storm waves.

The gap in the spit near the base has shifted over time toward the end of the spit (Sheet 3; Table 1). The 2011 gap was approximately 450 ft northwest of the gap mapped in 2003. With the exception of 2008, the gap has decreased in width since 2003.

Table 1. Brant Spit gap size (MHHW to MHHW) and location relative to base monument #1.

Year	MHHW Gap size (ft)	Distance from Base Monument (ft)
2003	545	450
2005	450	600
2008	507	560
2011	443	895

Spit Crest

Between the 2003 and 2005 surveys the location of the spit crest did not change appreciably (Sheet 3). However, the 2011 spit crest had shifted significantly since the 2005 survey, particularly north of the large MHHW gap, where the crest was up to 35 ft west of its 2003 location. Farther downdrift of there, the spit crest was closer to its 2003 location, but still remained west of it for the entire length. Toward the base of the spit however, the opposite trend could be seen. The spit crest tended to be north of the 2003 and 2005 location, and at one location had split into two distinct crests. This may be largely due to rapid accretion, which would leave behind remnant crests, or beach ridges, in the backshore. No spit crest was extracted from the 2008 LiDAR data.

Surface Change Analysis

Surface change maps between the 2003 CGS survey, 2008 LiDAR data, and 2011 CGS survey are shown in Sheet 4. During the 2003 to 2008 period the spit exhibited change across several areas on the spit. On the Bellingham Bay shore, erosion was the primary trend, although a large area of accretion was seen near the base of the spit and along the north side of Brant Point. The Portage Bay side of the spit exhibited accretion across its entire length, except two small areas of erosion near Brant Point. Together, this indicates translation of the spit toward Portage Bay through overwash or rollover processes.

The period between the 2008 LiDAR and the 2011 CGS survey showed a similar trend of southwestward translation of the spit with progradation of the higher elevation area northwestward from the base of the spit (Sheet 4). Spit translation toward Portage Bay was more pronounced in the central portion of the spit, as indicated by erosion on the Bellingham Bay side and accretion of the Portage Bay side through overwash or rollover processes. Additionally, the erosion on the eastern end of Brant Point can be seen in the surface change map. Here the shoreline has been eroded westward by as much as 200 ft in the previous 3 years. Much of the eroded material appears to have accreted on the western end of Brant Point, where the beach was up to 2–3 ft higher in 2011 than it was in 2008.

Overall, surface change between the 2003 and 2011 surveys followed the same trends of accretion near the base of the spit, Portage Bay-ward overwash and rollover of the central portion of the spit, and westward translation of Brant Point. However, the entire comparison area had gained a total of 3,500 cubic yards of sediment during the 8 years between surveys. Some of this net change was likely a result of incomplete topographic surface coverage. However, despite the planform changes to the spit, there appears to be more sediment in the system in 2011 as compared to 2003.

Conclusions

Brant spit has been a dynamic shoreform in the past 8 years, as may be expected of these types of large spits. Observation of various spit features and topography appear to indicate that an erosional “hot spot” is migrating along the length of the spit. This gap between MHHW has diminished in width somewhat since 2003, but remains a considerable size. The higher elevation backshore at the east end of Brant Point has also eroded. However, during the same period the base of the spit has experienced rapid accretion, and has added approximately 450 lineal ft of backshore area above MHHW to the spit, or almost 60 ft/year on average.

Further study will be necessary to help understand the primary drivers of shoreline changes at the spit. Wave-induced erosion and overwash of the spit could be major drivers of spit translation, although circulation within Portage and Bellingham Bays may play an active role in spit dynamics. The periodic nature of bluff erosion on Portage Island may result in “pulses” of sediment that enter the spit system. These discreet volumes of sediment would naturally be transported along the length of the spit, resulting in localized regions of erosion and accretion. Additional analysis of LiDAR, air photos, and historic mapping, in conjunction with more thorough analysis of all the data together, would allow for a better understanding of these processes.

ATTACHMENTS:

Sheet 1. Brant Spit and Vicinity

Sheet 2. Site Plan – 2011 Topography

Sheet 3. Site Plan – Spit Crest and MHHW Gap Comparison

Sheet 4. Site Plan – Surface Change 2003 to 2011 Analysis

Photo Page 1. Ground Photos Near Base of Spit

Photo Page 2. Ground Photos at Central and Northern End of Spit



Looking south from beach at base of spit



Looking west near base of spit



Vehicle track across spit near base



Looking northwest along base of spit



Looking northwest across southern gap in spit



Looking northwest across gap at +7.4 ft tide 9/9/11 5:14 PM

Photo Page 1. Ground photos taken 9/9/11 near base of Brant Spit, Lummi Indian Reservation.



Low elevation portion of Brant Spit looking northwest



Low elevation portion of Brant Spit looking northwest



Recently heavily eroded area near Brant Point end



Peat deposit exposed by erosion of the spit near Brant Point

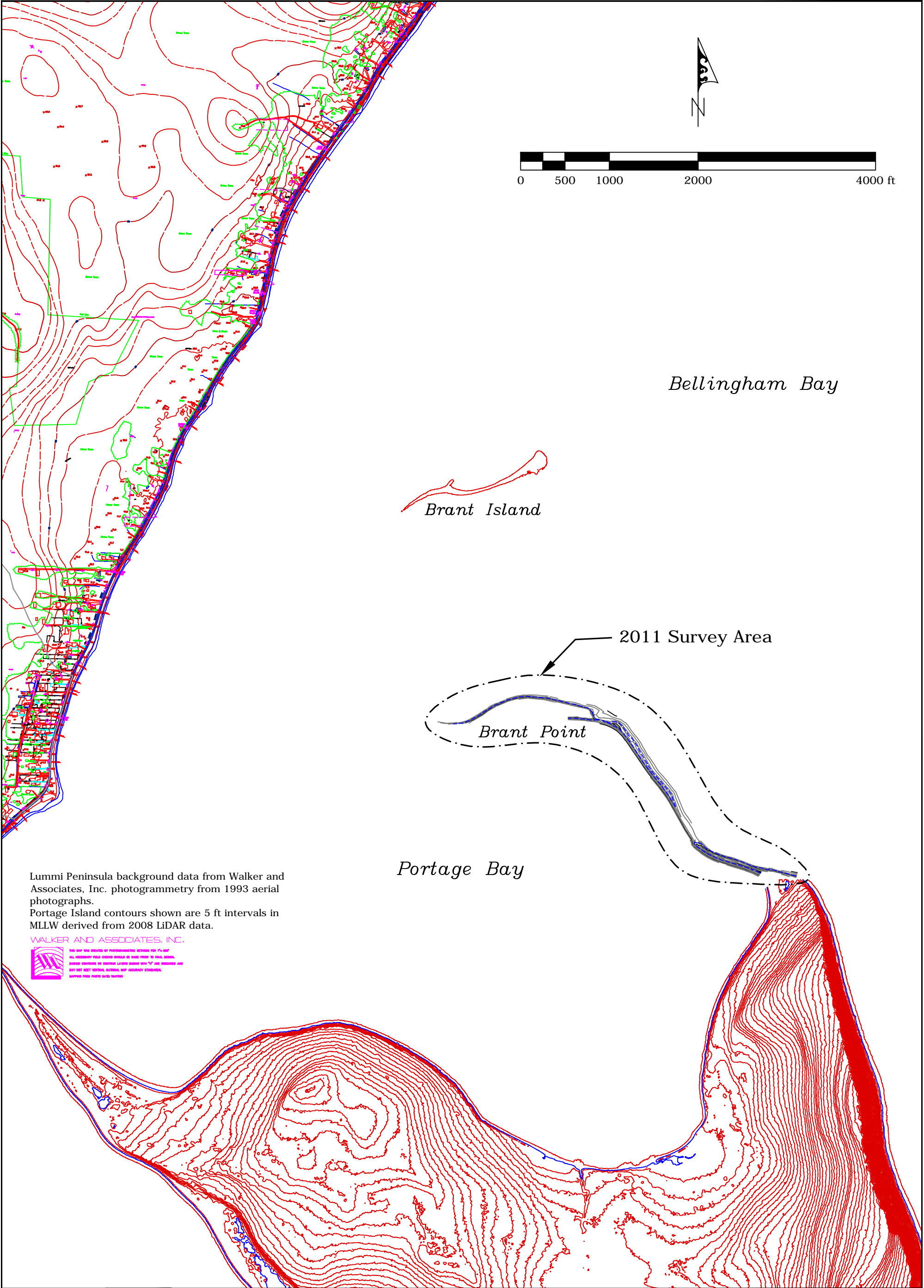


View looking southeast toward base of spit



Looking west along northern side Brant Point

Photo Page 2. Ground photos taken 9/9/11 along spit and Brant Point, Lummi Indian Reservation.



Lummi Peninsula background data from Walker and Associates, Inc. photogrammetry from 1993 aerial photographs.
Portage Island contours shown are 5 ft intervals in MLLW derived from 2008 LiDAR data.

WALKER AND ASSOCIATES, INC.




Brandt Spit Change Analysis

Brant Spit and Vicinity

Lummi Indian Business Council

DRAWN BY: JFW	REVISIONS
DESIGNED BY:	
CHECKED BY: JWJ	
DATE SURVEYED: 9/9/11	




COASTAL GEOLOGIC SERVICES

1711 Ellis St, suite 103
Bellingham, WA 98225
360-647-1845 - coastalgeo.com

OF: 4

1

MLLW=0.0'



SCALE: AS NOTED

DATE: 11/21/11

SHEET:

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33 ft
2011 gap

2003 Spit Crest

2005 Spit Crest

2011 Spit Crest

2011 Survey Extent

443 ft. 2011 gap

507 ft. 2008 gap

450 ft. 2005 gap

545 ft. 2003 gap

Brant Spit Base Mon #1
N: 630795.031
E: 1210515.384
Z: +10.64' MLLW

Bellingham Bay

Portage Bay



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REVISIONS

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DESIGNED BY:

CHECKED BY: JMW

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MLLW=0.0'

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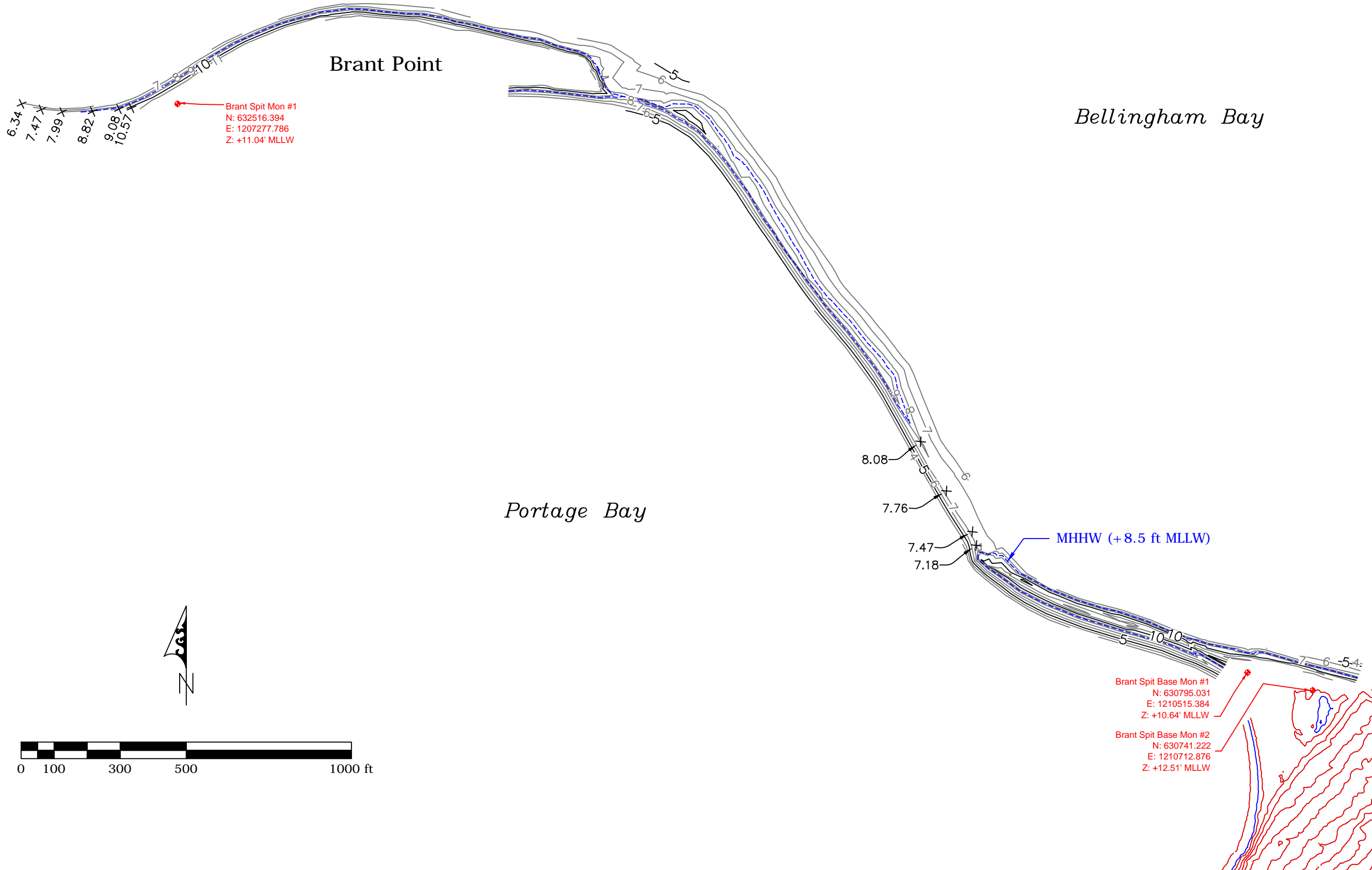
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Brant Spit Site Plan
2011 Topography
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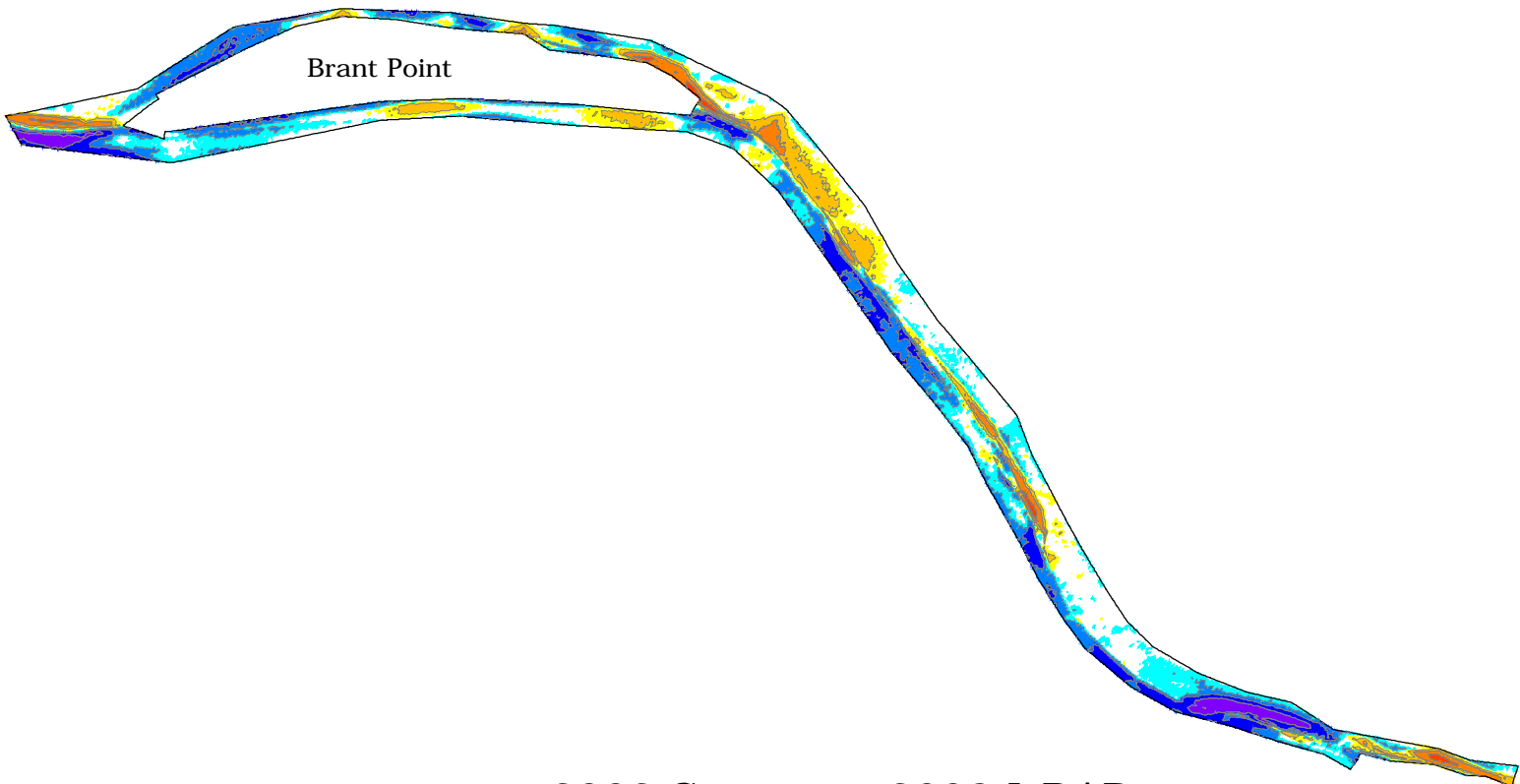


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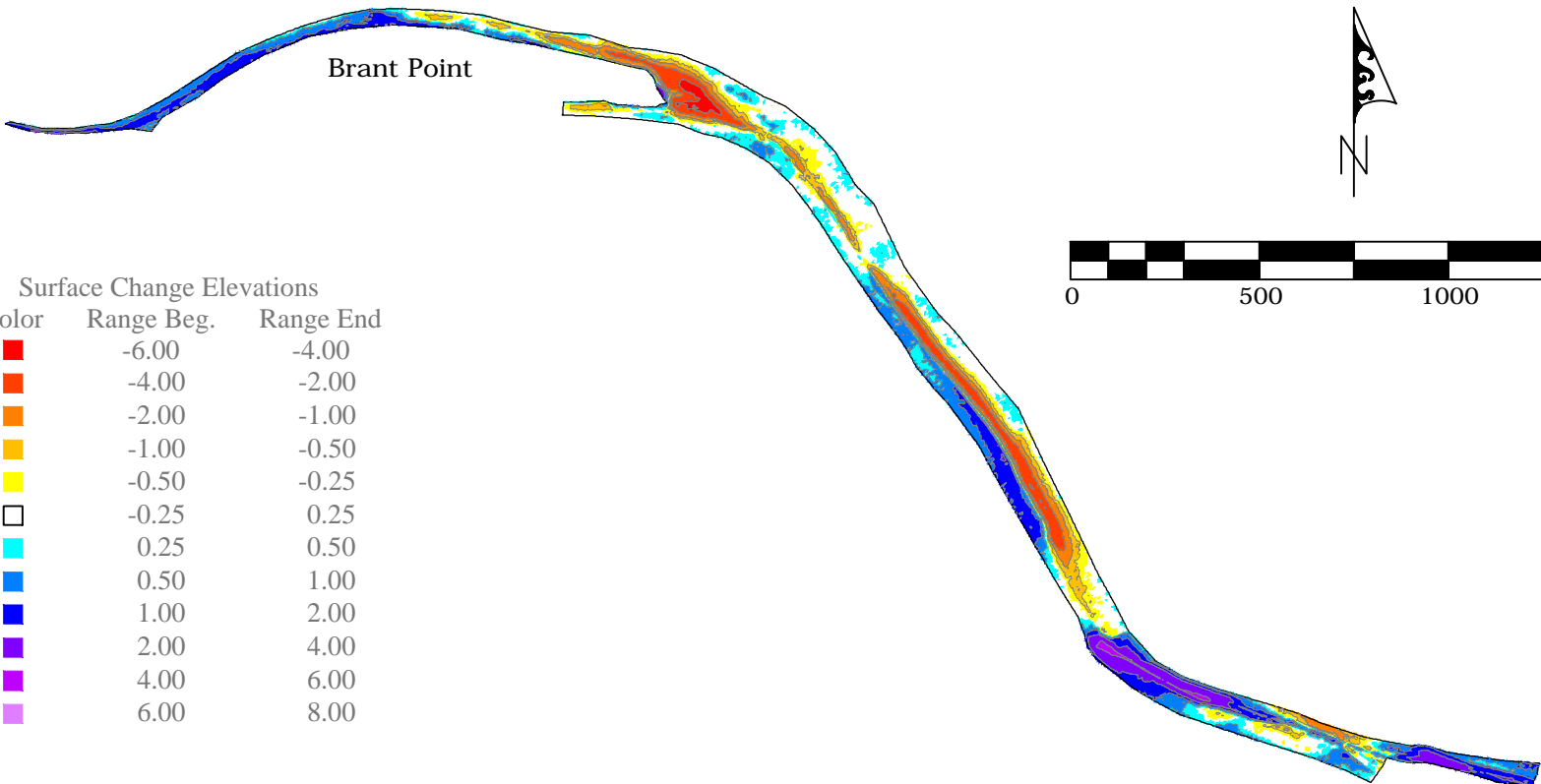
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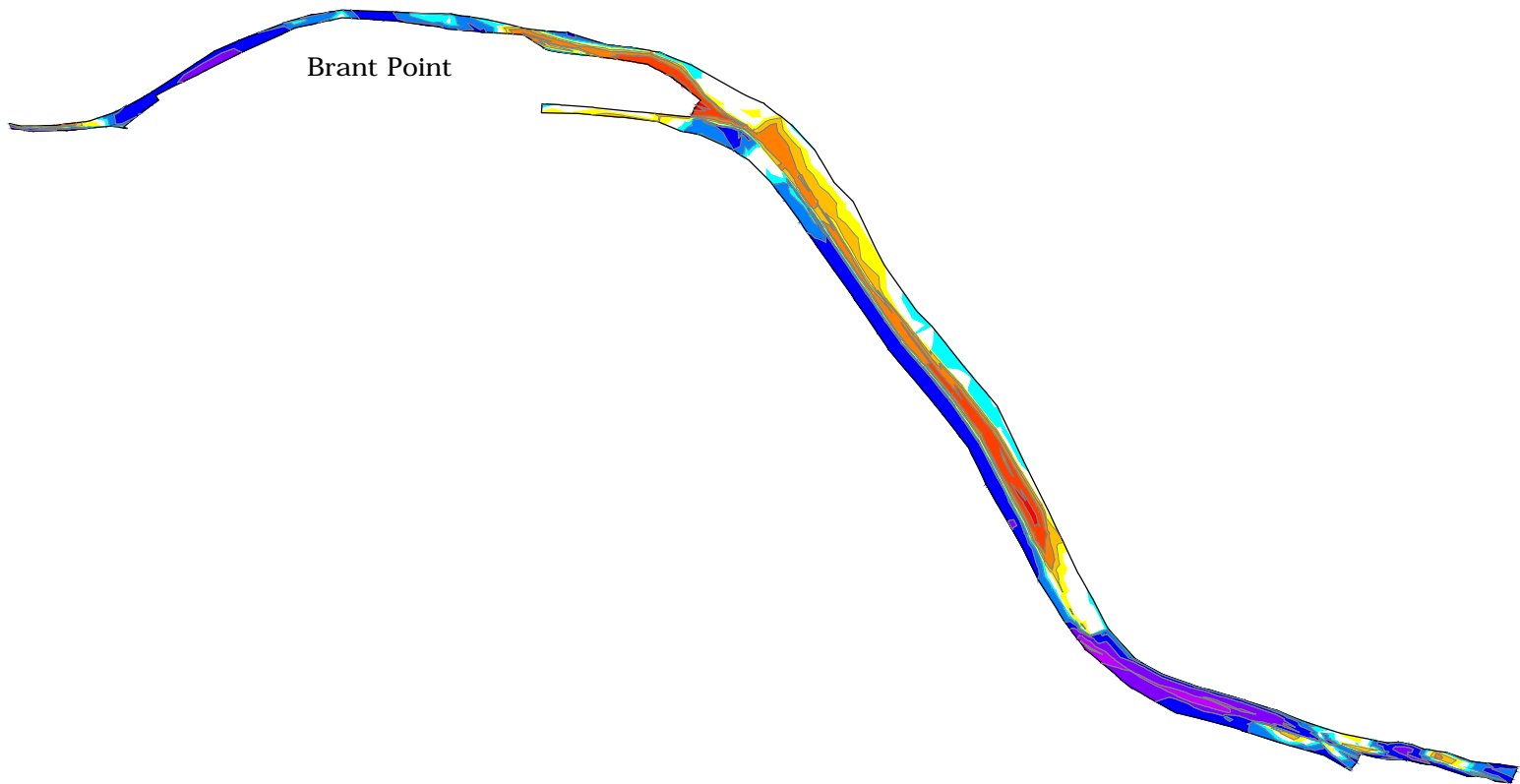
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2003 Survey to 2008 LiDAR



2008 LiDAR to 2011 Survey



2003 Survey to 2011 Survey